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THE THREE YEAR STABILITY OF SIX DIFFERENT RIGHTS-OF-WAY PLANT COMMUNITIES IN THE VICINITY OF ESSA TS AND THEIR INTERFERENCE POTENTIAL ON ASH, POPLAR, SPRUCE AND PINE TRANSPLANTS

Report No 90-166-K

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ABSTRACT

A previous study identified six different plant communities on the rights-of-way near Essa TS, Georgian Bay Region. This study reports on the changes in these communities between 1987 and 1989, and investigates the ability of these communities to affect the survival and growth of transplanted green ash (*Fraxinus pennsylvanica*), Carolina poplar (*Populus x canadensis*), red pine (*Pinus resinosa*) and white spruce (*Picea glauca*) seedlings.

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EXECUTIVE SUMMARY

THE THREE YEAR STABILITY OF SIX DIFFERENT RIGHTS-OF-WAY PLANT COMMUNITIES IN THE VICINITY OF ESSA TS AND THEIR INTERFERENCE POTENTIAL ON ASH, POPLAR, SPRUCE AND PINE TRANSPLANTS

D. Brown

The recent corporate initiative to reduce the use of herbicides in the rights-of-way vegetation management program has placed increased emphasis on the need to develop a vegetation cover which exerts a form of biological control. Such a control strategy was adopted by Ontario Hydro in the early 1970's, when selective herbicide applications were introduced to stimulate the development of vegetation which controls the growth of tree species. However, few studies have been undertaken to investigate the success of this strategy. For its effective application, persistent plant species or communities which are able to interfere with the establishment and growth of incompatible tree species must be identified.

A study was initiated in 1988 to determine if the various plant communities on the rights-of-way differed in their interference potentials. Seedlings of green ash (*Fraxinus pennsylvanica*) were transplanted into each of six different communities. Each treatment (community) quadrat was paired with a control quadrat, which was kept free of competing vegetation by covering the ground with a polyethylene sheet. This non-vegetated control was used to standardize the growth and survival of the trees in the treatment quadrats, thus removing site differences due to edaphic, climatic and disturbance factors. This study has been expanded in 1989 by including transplants of Carolina poplar (*Populus x canadensis*), white spruce (*Picea glauca*) and red pine (*Pinus resinosa*).

The results of the survival and growth of transplants in 1989 were specific for both the tree species and vegetation community. There were 4 significant interactions regarding tree survival: Community 1 stimulated the survival of white spruce, Community 2 inhibited the survival of ash and Community 3 inhibited spruce but stimulated ash survival. Three interactions were significant for the growth of the transplants: Community 3 inhibited pine, Community 4 inhibited poplar and Community 6 stimulated pine.

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To: Dr. D. Mills
Director of Research

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1.0 INTRODUCTION

The presence of herbaceous and low growing woody vegetation has been known to be detrimental to the growth of forest trees. The interference effects have been related to overshading of the tree seedlings by taller vegetation, competition for moisture and nutrients, and possible allelopathic inhibition (Brown 1989a, Fisher 1980). The forestry industry has attempted to reduce this interference by suppressing the ground vegetation with extensive site preparation prior to planting, and by following planting with herbicide treatments. Egler (1958) has proposed that rights-of-way managers take advantage of this situation by adopting a selective maintenance policy which encourages the growth of vegetation with a high interference potential. An integral component of this approach is the identification of such species or communities.

Although this identification may appear to be a relatively simple task, it is not. Vegetation is a very complex and dynamic entity. Communities undergo changes due to successional processes, cyclic variation, disturbances and random events. Even a simple lawn community, undergoing a cyclic mowing regime, can show considerable change in composition over a 10-year period (Austin 1980). Therefore it is difficult, but very important, to identify species which tend towards the formation of a persistent community which resists tree invasion.

A study integrating several methodologies is required. The vegetation in the region must be described and relationships with environmental and edaphic factors determined. Selected areas should then be sampled over a long period of time to determine successional trends. A high frequency of sampling is required at this point to distinguish between directional changes and random events. This information will be used to separate transitory communities from the longer lived, pseudostable ones. Experiments need to be conducted in the field to ascertain the interference effects of the various communities on

target tree species, and parallel, controlled laboratory experiments will be necessary to investigate the interaction between individual species and the target trees.

The first task, identification of the plant communities, was undertaken in a study conducted in 1987 (Brown 1988) on the rights-of-way in the vicinity of Essa TS. Six plant communities were found on these rights-of-way. Community 1 was dominated by sheep sorrel (*Rumex acetosella*), field horsetail (*Equisetum arvense*), and Canada bluegrass (*Poa compressa*); Community 2 by milkweed (*Asclepias syriaca*), strawberry (*Fragaria virginiana*) and sheep sorrel; Community 3 by bracken (*Pteridium aquilinum*), strawberry and upright bindweed (*Convolvulus spithamaeus*); Community 4 by Canada goldenrod (*Solidago canadensis*), violets (*Viola* spp.) and dandelion (*Taraxacum officinale*); Community 5 by strawberry, rough goldenrod (*Solidago rugosa*) and violets; and Community 6 by avens (*Geum* sp.), spiny leaved sow thistle (*Sonchus asper*), New England aster (*Aster novae-angliae*) and northern bedstraw (*Galium boreale*).

Communities 1, 2 and 3 were found on slightly acidic soils with low organic content (Brown 1988). The soils from the Community 3 quadrats had higher levels of potassium and phosphate. Community 4 vegetation occurred in areas with high concentrations of organic matter, calcium and nitrate. The Community 5 vegetation tended to be located at the more northerly sites, with acidic sandy soils with higher organic contents. Community 6 occurred on the most distinctive soil, an alkaline silty loam with high concentrations of calcium, magnesium and nitrate. Additional analysis has also indicated that soil moisture, as predicted from the ecological preferences of the species growing in each community, may also be influencing the species composition (Brown 1989b). Communities 2 and 3 tended to occur in the drier areas, while Communities 4 and 6 were found in moister areas.

These communities did not differ significantly in the frequency of occurrence of tree species (Brown 1988). However, this does not mean that each community is equally suitable (or unsuitable) for the creation of a stable cover, as the seed pressures exerted by the surrounding woodlots will be different at each site. A study which measures the relative competitive ability of each community on the growth of tree seedlings is necessary to better define the suitability of the communities as a right-of-way cover.

Such a study was initiated in 1988, when two-year old white ash (*Fraxinus pennsylvanica*) seedlings were transplanted into the six communities (Brown 1989b). The first year results suggest that the communities did differ in their interference abilities. Community 2 inhibited survival and growth, Community 3 increased survival but inhibited growth, and Communities 5 and 6 stimulated growth.

The continuing survival and growth of the ash is reported here for the second growing season. In addition, the scope of the study has been increased by planting Carolina poplar (*Populus X canadensis*), red pine (*Pinus resinosa*) and white spruce (*Picea glauca*) into the same communities in 1989. This study also partially addresses the dynamic nature of the right-of-way vegetation by comparing the vegetation in 1989 to that observed in 1987 and 1988 at the locations selected for this study.

2.0 METHODS

The sites selected for this study were those identified by the 1987 vegetation survey (Brown 1988) to primarily consist of one vegetation community. T32 and P150 were selected as representatives of Community 1 vegetation, T738 and T301 were selected for Community 2, T369 was selected for Community 3, T23 and P123 for Community 4, T698 and T255 for Community 5 and T834 for Community 6 (Table 1). The number of sites was increased in 1989 with the addition of T634 (Communities 2 and 5) and T45 (Community 4). The number of quadrats at P150 was increased to 10, and the quadrats at T32 were removed at the request of the land owner.

The ability of the 6 communities to interfere with survival and growth of the four tree species was estimated using a paired quadrat design. This design was selected to reduce between-site variability in the edaphic and microclimate factors not directly associated with the vegetation by pairing a non-vegetated control quadrat to each replicated treatment (vegetation community) quadrat. It is assumed that there is negligible differences between the paired treatment and control quadrats with respect to edaphic factors (soil texture, nutrients, pH, organic matter, moisture, *et cetera*), thus any observed differences in growth are solely due to the vegetation cover.

The treatment quadrats were arranged in transects perpendicular to the right-of-way, with 5 m spacing between each quadrat. A control quadrat was located 1 m from each treatment quadrat. The vegetation was removed from the controls in May of 1988 and 1989, and a double layer of landscaping fabric (a non-woven, spun bonded black polyethylene sheet (Quest Plastics, Mississauga)) was placed on the bare ground and anchored with nails.

Five 2 year-old green ash seedings were transplanted into each 1 x 1 m treatment and control quadrat between May 30 and June 7, 1988. These were thinned to 1 surviving ash per quadrat in 1989. One each of a 5 year-old white spruce, a 5 year-old red pine, and a 15 cm cutting from the shoot of a 2 year-old Carolina poplar was added to each treatment and control quadrat in the spring of 1989. The height of each tree was measured at the time of planting and in September, 1989. The net annual growth for each quadrat was calculated as the mean difference between the spring and fall measurements for the surviving trees in each quadrat, and thus represents the growth in 1989 only.

The vegetation in each treatment quadrat was analyzed using local frequency. Each 1 x 1 m quadrat was subdivided into 25 sections; local frequency was reported as the number of occurrences out of 25. All vegetation except mosses were included in the survey. This value was used in a detrended correspondence analysis ordination (DECORANA, Hill 1979, Hill and Gauch 1980). The ordination initially locates the sites in an n-dimensional space based on floristic composition (where n is the total number of species at all sites). New axes are then derived to best represent the spatial arrangement of the samples, reducing the complexity to a few (1 - 4) dimensions which attempt to display the major gradients in the data set. The distance separating the quadrats is related to the degree of similarity in the vegetation.

Table 1

The location of the sites used in the transplant study

Tower & Transmission Line	Community Type	# of Quadrats	Comment
T32 Essa to Alliston	1	12	removed in 1989
T45 Alliston to Orangeville	4	10	added in 1989
P123 Essa to Stayner	4	10	
P150 Essa to Stayner	1	10	2 quadrats added in 1989
T738 Essa to Waubaushene, West	2	10	herbicide treated in 1988
T634 Essa to Waubaushene, West	2	10	added in 1989
T634 Essa to Waubaushene, West	5	10	added in 1989
T23 Essa to Minesing	4	10	
T698 Essa to Waubaushene, West	5	10	
T255 Essa to Orillia line	5	10	
T301 Essa to Orillia	2	10	
T369 Essa to Orillia	3	20	
T834 Essa to Clairville, West	6	20	

Taxonomy of herbaceous vegetation follows Fernald (1950); woody vegetation follows Soper and Heimburger (1982) and Hosie (1979).

3.0 RESULTS and DISCUSSION

3.1 Effect of vegetation on the transplanted trees

Survival of the trees planted in 1989 did not vary between species (53% for poplar, 60% for spruce and 61% for pine). Although there was site to site variation in survival, the presence of a particular plant community did not affect the survival of either the poplar or pine (Figure 1). White spruce survival was stimulated by the presence of vegetation Community 1, and inhibited by vegetation Community 3. Live ash were only found in 33% of the quadrats. As in the previous year, ash survival was inhibited by Community 2 and stimulated by Community 3 (Figure 1).

The growth of the surviving trees is shown in Figure 2. Poplar had the highest growth rates while pine showed the lowest. The growth data could not be analyzed using the split-plot design, as several of the paired quadrats did not contain any surviving trees. Thus to determine if the vegetation had any effect on tree growth, the Students t statistic was used to compare growth in the vegetated and non-vegetated quadrats within each community for each tree species. Only 3 treatments may be considered significant by this comparison. Poplar growth was inhibited by the presence of vegetation from Community 4 (p= 0.0009), and potentially Community 1 (p = 0.109), while pine was inhibited by Community 3 (p = 0.002) and stimulated by Community 6 (p = 0.019) and possibly Community 1 (p = 0.127). The presence of vegetation did not affect the growth of ash (p = 0.4 to 0.9) or spruce (p = 0.4 to 0.8) during the 1989 growing season.

There appear to be some contradictions between the effect the various communities have on survival and growth. Community 6 has low survival in both the pine and ash, however, the growth of the surviving trees in the vegetation is comparable to or higher than that in the other communities.

The biomass of the central 0.5 x 0.5 m portion of the vegetated plots ranged from 71.4 $\pm$ 5.9 g in Community 6 to 95.2 $\pm$ 7.2 g in Community 2 (mean $\pm$ SE, table 2). There was no significant difference in the biomass between the communities (ANOVA, F = 1.048, p = 0.3926) and there was no apparent relationship between vegetation biomass and either growth or survival of the trees.

3.2 Change in vegetation since 1987

The interpretation of these results is confounded by the dynamic nature of the vegetation which constitutes the treatment plots. The results of last year's vegetation survey (Brown 1989b) suggested that the separation between vegetation classes 1, 2 and 4 was becoming less distinct. The vegetation ordination of the 1989 data is shown in Figure 3. Communities 1, 3 and 6 can still be identified as distinct groups, although the Community 1 quadrats are no longer as distinctive as they were in 1987. Some quadrats in Community 5 cannot be distinguished from those in Community 2. The sites which represent

Figure 1: The effect of the vegetation community on the survival of the transplanted trees

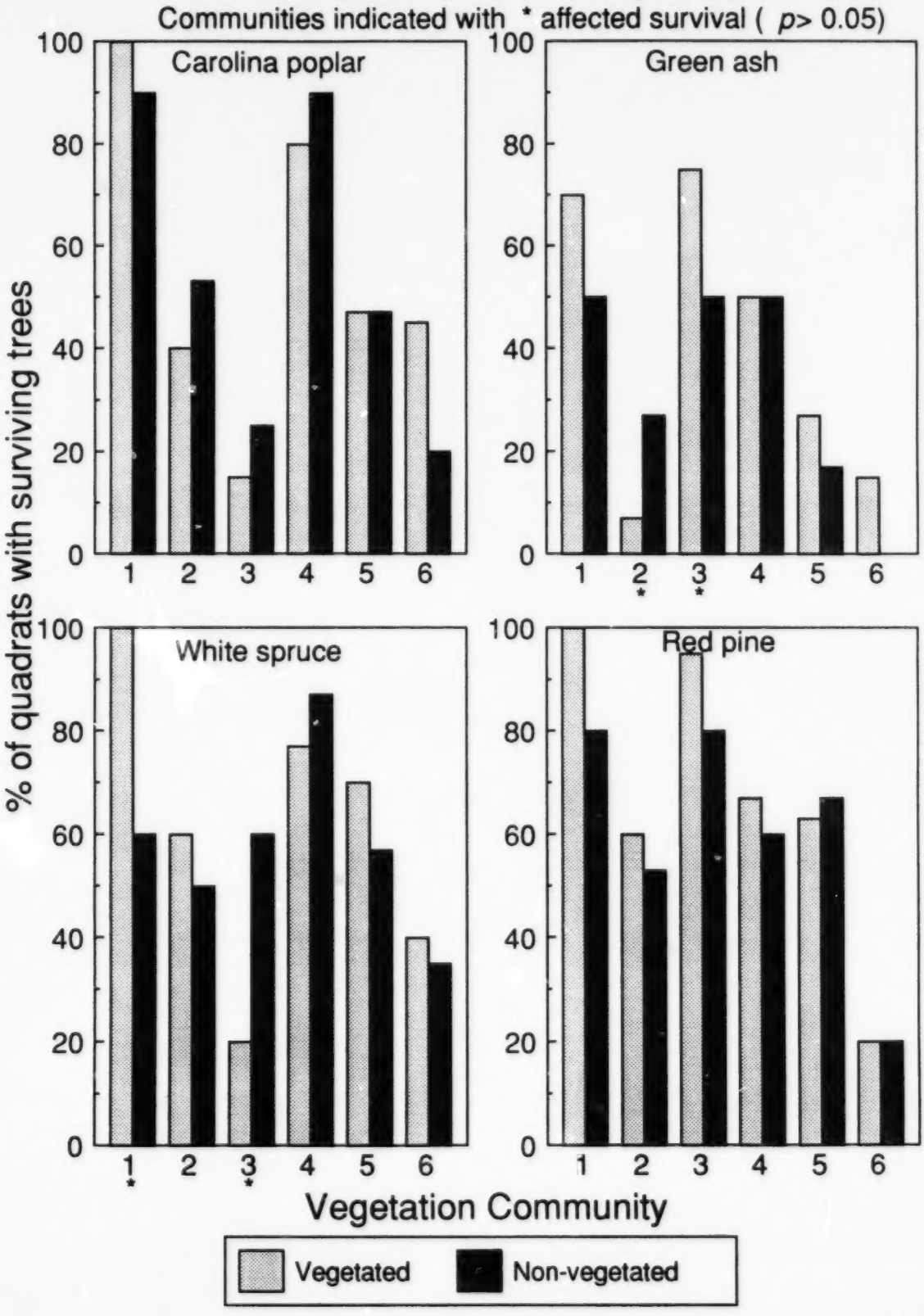

Figure 2: The effect of vegetation community on the growth of the transplanted trees

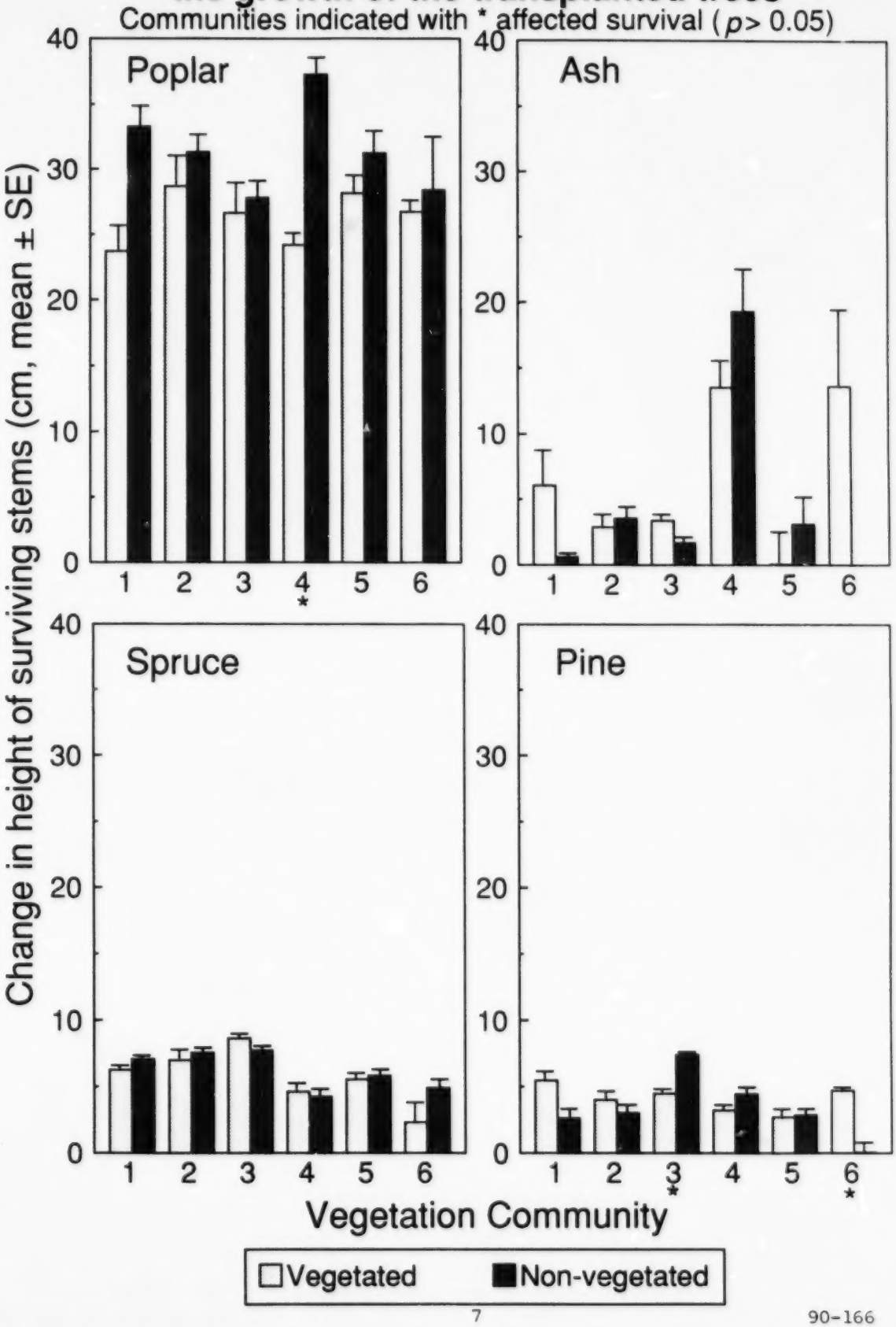

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Table 2

The biomass of the vegetation in the central 0.5 x 0.5 m of each vegetated quadrat.

Community	Biomass (g) mean ± SE
1	86.9 ± 6.5
2	95.2 ± 7.2
3	88.5 ± 7.7
4	88.9 ± 7.7
5	87.3 ± 6.0
6	71.4 ± 5.9

the Community 4 vegetation, which started to separate into 2 separate groups in 1988, are continuing this trend.

It deserves comment that the vegetation within a site is more similar than the vegetation between sites of the same community (Figure 3). This is most apparent in Community 4, where the quadrats from T23 are forming a separate group. This is also evident at the two transects at T634, which were placed in separate communities in the initial study (Brown 1988), but are indistinguishable from each other in the 1989 study. The high within site vegetation similarity may explain why the communities which are now represented by 1 only site (Communities 1, 3 and 6) appear to be maintaining their integrity between 1987 and 1989, while those communities represented by 2 or more sites (2, 4, and 5) are diverging. The lack of site replication within these communities may make it difficult to investigate the long term stability of the various communities.

The ordination shown in Figure 3 represents a graphical interpretation of the relative similarities in vegetation, however, it provides no true indication of the change in vegetation over time. Table 3 provides a summary of the more frequently occurring species in each community. There has been very few changes in the frequency of the major 4 to 5 species in each community. Thus the year to year changes in vegetation have primarily been restricted to the intermediate and rarer species. The largest change observed in 1989 has occurred in Community 1, and this probably reflects the loss of the quadrats at T32 rather than a large change in the vegetation at the remaining site (P150).

Figure 3: Detrended correspondence analysis ordination of the vegetation in 1989.

Quadrats are labled according to the site and each community is circled

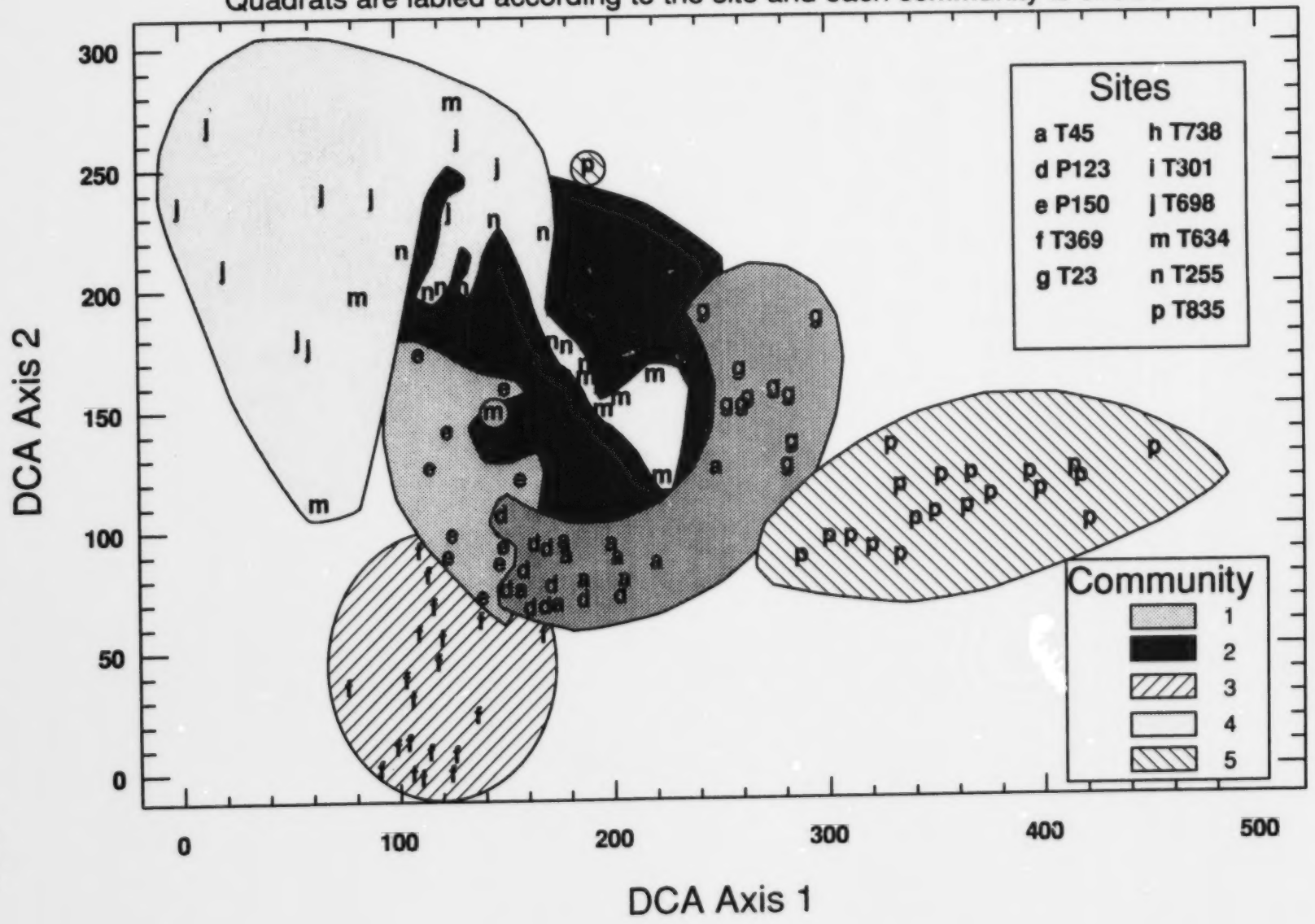

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Table 3

The species occurring with a freqency greater than 40% in any of the vegetation communities in either 1987, 1988 or 1989.
See the Appendix A for list of the species codes.

Community 1				Community 2				Community 3			
Species	% Frequency			Species	% Frequency			Species	% Frequency		
	1987	1988	1989		1987	1988	1989		1987	1988	1989
Poa com	85	100	100	Poa com	40	100	96	Poa com	64	100	-
Rume ace	92	90	100	Rume ace	73	35	96	Pter aqu	100	100	100
Chry leu	69	75	100	Frag vir	80	95	92	Poa com	55	100	100
Pter aqu	46	65	100	Ascl syr	93	95	85	Conv spi	73	85	95
Plan lan	38	40	100	Satu vul	47	30	85	Frag vir	73	80	85
Hype per	69	40	90	Rubu ida	40	45	62	Rubu all	45	80	70
Equi arv	85	70	80	Geum spp	40	0	42	Apoc and	45	65	70
Care syl	0	65	80	Equi hye	33	45	38	Desm glu	45	55	65
Frag vir	38	50	80	Rubu occ	40	0	0	Achi mil	27	55	65
Soli can	46	45	80					Aste low	36	55	15
Ascl syr	77	75	70					Pani cla	36	45	75
Agro rep	38	40	30					Oryz asp	50	0	0
Pote rec	62	45	0					Aste cor	45	0	90
								Seca cer	55	0	0

Table 3 (cont'd)

The species occurring with a freqency greater than 40% in any of the vegetation communities in either 1987, 1988 or 1989.
See the Appendix A for list of the species codes.

Community 4				Community 5				Community 6			
Species	% Frequency			Species	% Frequency			Species	% Frequency		
	1987	1988	1989		1987	1988	1989		1987	1988	1989
Soli can	100	90	97	Frag vir	95	75	97	Geum spp	94	85	85
Viol sp.	92	90	93	Poa com	14	75	90	Poa com	70	0	80
Poa com	31	90	93	Care syl	0	75	90	Agro rep	0	80	65
Frag vir	54	85	93	Rume ace	50	65	73	Aste nov	67	60	50
Satu vul	0	40	67	Rubu ida	64	35	73	Lysi cil	56	40	45
Care syl	0	55	63	Viol sp.	86	55	57	Gali bor	67	50	35
Tiar cor	54	40	63	Soli can	59	55	53	Corn sto	28	45	30
Agro sp.	0	45	57	Soli rug	86	50	50	Care sco	90	0	15
Tara off	69	15	57	Rubu all	14	45	47	Onop aca	0	50	0
Aste low	46	45	53	Oxal mon	50	20	37	Sonc asp	89	25	0
Dacu car	62	40	53	Onoc sen	59	0	37	Poa cha	56	0	0
Geum spp	46	70	50	Athy fil	55	0	30	Agri sp.	50	0	0
Rubu ida	46	50	40	Vero off	27	40	0	Scut ell	56	0	0
Chry leu	38	45	37	Rubu occ	45	0	0				
Clem vir	46	50	33								
Gali tri	46	30	30								
Prun vir	46	25	27								
Soli alt	0	55	23								
Plan lan	38	45	20								
Soli rug	62	15	17								
Sonc arv	38	45	0								
Prun vul	46	30	0								
Gera sp	54	15	0								
Scut ell	62	0	0								

4.0 CONCLUSIONS

1. More replication of sites should be included in future studies.

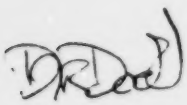
2. The interference effects are specific to the individual community and tree species. The same community may inhibit one tree species while stimulating another.

3. As this is at an early stage of an ongoing project, conclusions regarding the interference potentials and stability of the various communities cannot be inferred at this time.

5.0 ACKNOWLEDGMENTS

I would like to thank A. Spring, J. Heich and M. McKay for their assistance in the field survey, and the staff of the Georgian Bay Region for their willing cooperation in this study.

Approved by:



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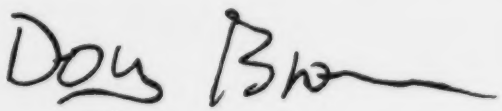

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REFERENCES

Austin, M.P. 1980. An exploratory analysis of grassland dynamics: an example of lawn succession. *Vegetatio* 43, 87-94.

Brown, D. 1988. The relationship between vegetation, soil texture, nutrient status and herbicide treatments on transmission rights-of-way in the vicinity of Essa TS, Georgian Bay Region. *Ontario Hydro Research Division*, Report 88-211-K. Toronto. 35pp.

Brown, D. 1989a. The use of cover crops for the maintenance of rights-of-way vegetation: a survey of the literature on succession, cover crops, competition and trees. *Ontario Hydro Research Division*, Report 89-275-K. Toronto. 41pp.

Brown, D. 1989b. The stability of six different rights-of-way plant communities in the vicinity of Essa TS and their interference potential on *Fraxinus pennsylvanica* transplants. *Ontario Hydro Research Division*, Report 89-88-K. Toronto. 22pp.

Egler, F.E. 1958. Science, industry, and the abuse of rights-of-way. *Science* 127, 573-580.

Fernald, M. L. 1950. *Gray's Manual of Botany*. D. van Nostrand and Co., New York.

Fisher, R.F. 1980. Allelopathy: a potential cause of regeneration failure. *Journal of Forestry* 78, 346-350.

Hill, M. O. 1979. *DECORANA. A fortran program for detrended correspondence analysis and reciprocal averaging*. Cornell University, Ithaca, N.Y.

Hill, M.O. and H.G. Gauch Jr. 1980. Detrended correspondence analysis: an improved ordination technique. *Vegetatio* 42, 47-58.

Hosie, R. C. 1979. *Native Trees of Canada*. 8th ed. Fitzhenry and Whiteside Ltd, Don Mills.

Soper, J. H. and M. L. Heimburger. 1982. *Shrubs of Ontario*. Royal Ontario Museum, Toronto.

Appendix A

The List of species codes used in Table 3.

Code	Common Name	Scientific name
Achi mil	yarrow	*Achillea millefolium*
Agri sp.	tall hairy agrimony	*Agrimonia gryposepala*
Agro rep	couch grass	*Agropyron repens*
Agro sp.	bentgrass	*Agrostis sp.*
Apoc and	spreading dogbane	*Apocynum androsaemifolium*
Ascl syr	common milkweed	*Asclepias syriaca*
Aste cor	heart-leaved aster	*Aster cordifolius*
Aste low	Lowrie's Aster	*Aster lowrieanus*
Aste nov	New England aster	*Aster novae-angliae*
Athy fil	lady fern	*Athyrium filix-femina*
Care sco	pointed broom sedge	*Carex scoparia*
Care syl	wood sedge	*Carex sylvatica*
Chry leu	ox-eye daisy	*Chrysanthemum leucanthemum*
Clem vir	virgin's-bower	*Clematis virginiana*
Conv spi	upright bindweed	*Convolvulus spithamaeus*
Corn sto	red osier dogwood	*Cornus stolonifera*
Dacu car	wild carrot	*Daucus carota*
Desm glu	tick-trefoil	*Desmodium glutinosum*
Equi arv	field horsetail	*Equisetum arvense*
Equi hye	scouring rush	*Equisetum hyemale*
Frag vir	strawberry	*Fragaria virginiana*
Gali bor	northern bedstraw	*Galium boreale*
Gali tri	sweet bedstraw	*Galium triflorum*
Gera sp	wild geranium	*Geranium maculatum*
Geum spp	yellow avens	*Geum aleppicum*
Hype per	St. John's-Wort	*Hypericum perforatum*
Lysi cil	fringed loosestrife	*Lysimachia ciliata*
Onoc sen	sensitive fern	*Onoclea sensibilis*
Onop aca	scotch thistle	*Onopordum acanthium*
Oryz asp	mountain rice	*Oryzopsis asperifolia*
Oxal mon	wood sorrel	*Oxalis montana*
Pani cla	deer-tongued grass	*Panicum clandestinum*
Plan lan	English plantain	*Plantago lanceolata*
Poa cha	meadow grass	*Poa chaixii*
Poa com	Canada bluegrass	*Poa compressa*
Pote rec	rough cinquefoil	*Potentilla recta*
Prun vir	choke cherry	*Prunus virginiana*
Prun vul	selfheal	*Prunella vulgaris*
Pter aqu	bracken	*Pteridium aquilinum*
Rubu all	common blackberry	*Rubus allegheniensis*
Rubu ida	red raspberry	*Rubus idaeus*
Rubu occ	black raspberry	*Rubus occidentalis*
Rume ace	sheep sorrel	*Rumex acetosella*
Satu vul	basil	*Satureja vulgaris*
Scut ell	common skullcap	*Scutellaria epilobiifolia*

Appendix A(cont'd)

The List of species codes used in Table 3.

Code	Common Name	Scientific name
Seca cer	rye	*Secale cereale*
Soli alt	tall goldenrod	*Solidago altissima*
Soli can	Canada goldenrod	*Solidago canadensis*
Soli rug	rough goldenrod	*Solidago rugosa*
Sonc arv	field sow-thistle	*Sonchus arvensis*
Sonc asp	spiny sow thistle	*Sonchus asper*
Tara off	common dandelion	*Taraxacum officinale*
Tiar cor	false miterwort	*Tiarella cordifolia*
Vero off	common speedwell	*Veronica officinalis*
Viol sp.	violet	*Viola sp.*